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THE

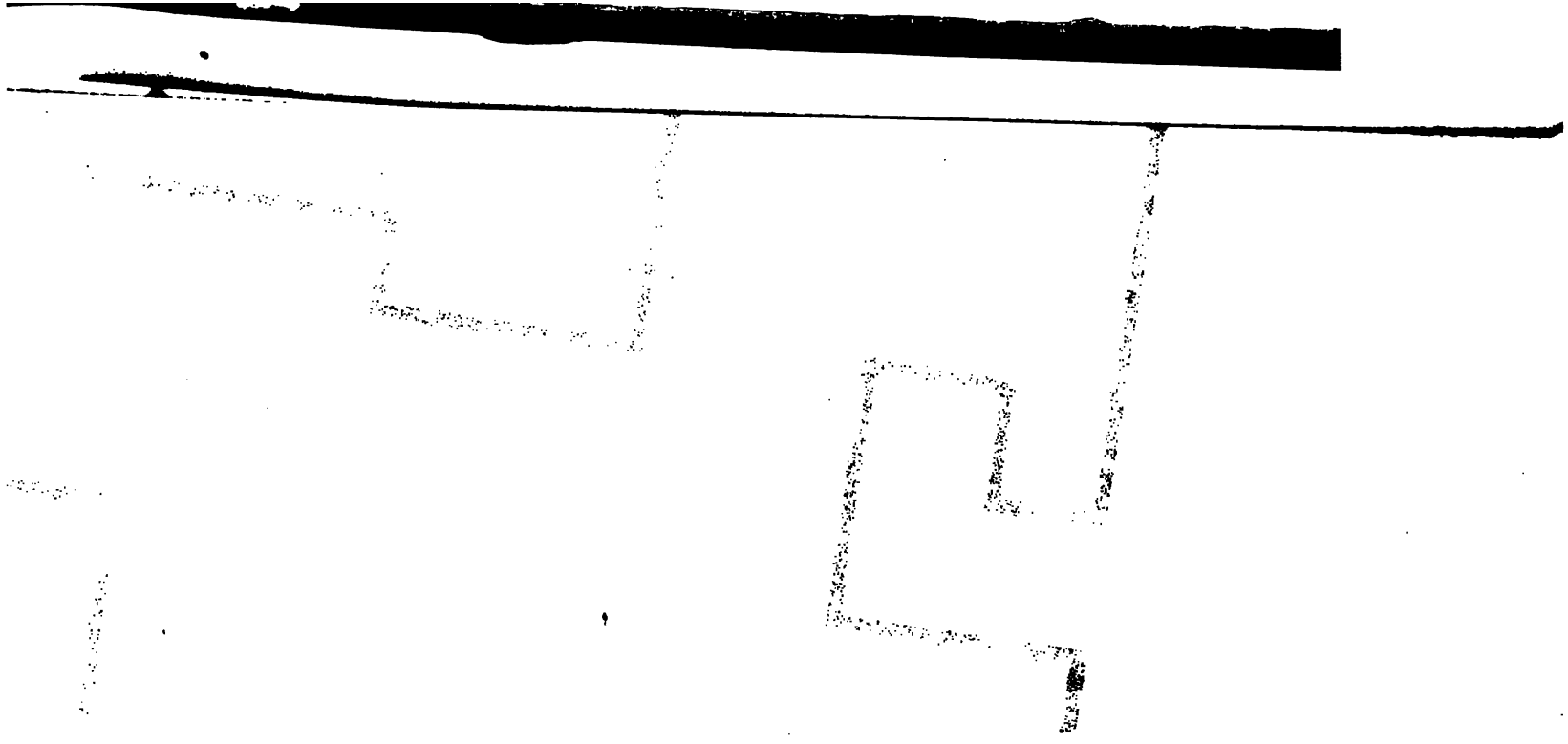
GREAT WATER-POWER

OF THE

ST. LOUIS RIVER

AT THE

HEAD OF LAKE SUPERIOR



REPORT

ON THE

WATER-POWER

OF THE

ST. LOUIS RIVER

1888

McLAUGHLIN BROS. CO., PRINTERS
112 AND 114 SOUTH THIRD STREET
PHILADELPHIA

BIRKINBINE,
ENGINEERING OFFICES,
25 N. E. City Hall Square,
PHILADELPHIA, February 10th, 1888.

J. M. BUTLER, Esq.
Secretary and Treasurer, St. Louis River Water-power Co.
Room 21, 119 S. Fourth St, Philadelphia.

DEAR SIR: With this, please find my report upon the water-power of the St. Louis River in the States of Minnesota and Wisconsin.

This report is based upon data collected in four visits to the property of your company, supplemented by examinations of the reports of others, to which reference will be made in the text.

Yours respectfully,

JOHN BIRKINBINE.

REPORT

ON THE

WATER-POWER OF THE ST. LOUIS RIVER

A section of the State of Minnesota, 100 miles north of the city of Duluth, is notable on account of its mineral wealth, and also by reason of being the headwaters for three great drainage-basins. Here, within twelve miles, are sources which form streams flowing

[a] Into the Mississippi River, and thence into the Gulf of Mexico.

[b] Into Vermilion Lake, and thence to the Atlantic Ocean via Hudson's Bay.

[c] Into the St. Louis River, and thence by the chain of great lakes, the St. Lawrence River and Bay, into the Atlantic Ocean.

This water-divide is, however, of moderate elevation, being from 1,600 to 2,000 feet above tide, or 1,000 to 1,400 feet above Lake Superior. Where the Duluth and Iron Range Railroad crosses from the drainage-basin of Lake Superior to that of Hudson's Bay, the maximum elevation is 1,597 feet above tide. This section of St. Louis County, Minnesota, consists of a series of alternating and interlacing swamps and ridges, covered with timber, forming excellent gathering-ground for water. With the exception of the territory opened up by the development of the iron-ore mines in the vicinity of Vermilion Lake and the construction of the Duluth and Iron Range Railroad connecting these mines with Lake Superior, or of that explored by the United States engineers in the construction of storage-reservoirs to maintain the flow of the Mississippi River, this section has been until very lately an unbroken wilderness.

In 1883, when my first report upon the water-power of the St. Louis River was prepared, the vicinity described was inaccessible except by tedious overland journey or by following the streams in birch-bark canoes to portages. Now, however, the exploitation of the deposits from which in four years one million tons of excellent iron-ores have been taken, and carried seventy miles to Lake Superior for shipment eastward, has brought a population of 8,000 to 10,000 to this vicinity, and exploration-work to the east is rapidly developing new territory and populating the district. Most of this development, however, is on the drainage-area which ultimately leads into Hudson's Bay, and does not materially influence that which now commands attention, viz.: the St. Louis River basin. The same may be said concerning the dams constructed by the Government engineers at the headwaters of the Mississippi; but the data collected in the surveys, gaugings, etc., offer valuable assistance in determining the quantity of rain falling on the watershed of the St. Louis River, and consequently of estimating the minimum and average flow of the stream and the power which can be developed by utilizing the water.

The settlement of the territory adjacent to the St. Louis River drainage-area will naturally affect its utilization for agricultural purposes; but so much of the swamp-land is covered with timber of comparatively little commercial value, that the denudation of the forests does not promise to be as rapid as the neighboring development might indicate.

REPORTS AND ESTIMATES.

The possibilities of utilizing the water-power of the St. Louis River attracted attention in the early settlement of the head of Lake Superior, and the opportunities offered for transforming the picturesque "dalles" into sources of power for manufacturing-purposes have been examined by numerous persons skilled in the various industries or in the specialty of hydraulics.

In 1870, Mr. James B. Francis, C. E., of Lowell, Mass., reported upon the method of developing a portion of the water-power of the St. Louis River at Thomson, Minnesota.

In 1871, Mr. C. S. Hollingsworth, C. E., made an estimate of the power which could be supplied by the St. Louis River.

In 1872, Mr. J. F. Stevens, C. E., of Minneapolis, prepared estimates of the cost of improving this water-power.

Messrs. P. S. Harris, L. S. Bayles, Geo. R. Stuntz, and Jos. McIntyre, C. E., have also surveyed the river or estimated for its improvement.

In 1883, Mr. John Birkinbine, C. E., of Philadelphia, made an examination of the water-power of the St. Louis River, and prepared a full report upon it, using in connection with his data such of the information previously collected as had been preserved.

In 1884, Mr. R. C. Reid, C. E., of Edinburgh, Scotland, prepared a report for British interests, in which he endorses and uses many of the figures presented by the writer in the preceding year.

In 1887, Mr. E. C. Burns, C. E., of Jamestown, New York, prepared a report upon data collected in a visit to the "dalles" and to the drainage-area of the St. Louis River, in company with the writer.

In the same year, Mr. A. E. Lehman, C. E., of Philadelphia, spent several weeks making the necessary surveys of the "dalles" of the St. Louis River, from which the accompanying excellent topographical map and profile have been prepared.

The present report will therefore refer to the work of all of these gentlemen, and, while it will in some features repeat from the writer's report of 1883, it will also quote from other reports and embody data collected in each of the four visits to this interesting section of the country.

SKETCH OF THE ST. LOUIS RIVER.

The St. Louis River has a length of over 100 miles, and is formed by several important branches flowing south to southwest with but slight declivity, until they unite in a common stream which cuts its way through slate and sandstone barriers, and, bending abruptly to the east, dashes by picturesque cascades, rapids, and cataracts of impressive size, to the level of Lake Superior. Of the total fall (approximately 1,000 feet) of the

river, 540 feet are between Knife Falls and Fond du Lac, a distance of 16 miles; the latter place was for many years the head of lake-navigation, and is fifteen miles distant from Duluth. The river may therefore be considered as consisting of:

1st. The tributaries draining timbered areas, and falling, say 460 feet in seventy miles.

2d. The "dalles" or rapids where the river cuts through the rocky barrier, falling 540 feet in sixteen miles.

3d. The navigable stream (without fall), extending fifteen miles from the foot of the "dalles," near Fond du Lac, to Duluth harbor, at the head of Lake Superior.

The St. Louis River, considered as the most important tributary of Lake Superior, would seem destined to achieve a reputation for the wealth produced by utilizing its water-power, much greater than now accredited to it on account of the natural beauties of the "dalles." "It is itself the ultimate terminus of, all things considered, the most remarkable system of waterways on the surface of the globe, stretching from the Atlantic Ocean on the east to the heart of the North American continent on the west," through territory which embraces our great grain, lumber, iron-ore, and copper resources, and past much of the nation's industrial and commercial development.

"What more picturesque journey can be described than one which would be made by a log starting near the low continental divide at the headwaters of the St. Louis River, at an elevation of 1,600 feet above the sea, down this river and through the "dalles" into the calm waters of St. Louis Bay, and then, with an average volume of not less than 2,400 cubic feet per second, through Superior Bay, out into Lake Superior, whose elevation is 601.78 feet, which it traverses for 375 miles, leaving it with a volume of 90,783 cubic feet of water per second pouring over the Sault Ste. Marie, and then through the St. Mary River into Lake Huron (elevation 581.28 feet), thence through St. Clair Lake and river with a volume of 234,000 cubic feet per second to the Detroit River and Lake Erie (elevation 572.86), from which it emerges through the Niagara River with a volume of 243,000 cubic feet per second, and dashes over the rapids and cataract to Lake Ontario (elevation 246.61 feet)? Traversing this, the last lake of the great chain, it completes the journey of 1,500 miles through

them and the St. Lawrence River, rushing past Ogdensburg with a volume of 325,000 cubic feet per second, and descending, often by rapids, to the ocean with an immensely augmented volume through the St. Lawrence Bay. A truly picturesque but hazardous journey!"*

AVAILABLE FALL OF THE ST. LOUIS RIVER.

The portion of the river considered as most available for utilization in the production of power is the ten miles between Thomson and Fond du Lac, where the measured fall reported by Mr. Lehman is 443 feet. The surveys which have been made provide for the utilization of but 364 feet of this fall, by the erection of ten dams from nine to twenty feet in height and aggregating 124 feet in height. In several places, a large power can be secured by simply diverting the water by a wing-dam, and it is believed to be practicable to utilize more of the fall of the stream than the above indicates. The profile of the river and the locations for dams will be discussed later.

Using the Fairbairn formula of one cubic foot of water falling twelve feet per second (or twelve cubic feet falling one foot per second) as equal to one horse-power, we have an idea of the value of this stream for power; for, *in a utilized fall of* 360 *feet, thirty horse-power is developed by every cubic foot of water passing down the river per second.* To determine, therefore, the possibilities of the stream, we must know the volume of water it discharges; and estimates of this, in the absence of actual gaugings covering different seasons and conditions, must be based upon the area of watershed and the amount of rainfall on the territory drained.

DRAINAGE-AREA OF THE ST. LOUIS RIVER.

As the water flowing in a stream is only a portion of such as is deposited by rains falling on the territory tributary to it, it is necessary, before attempting an estimate of the volume of water

* From "Resources of the Lake Superior Region," Transactions American Institute of Mining Engineers, Vol. XVI.

in the river, to know its drainage-area. To secure this information, I made diligent inquiry, visited the headwaters, and used the largest and most correct maps obtainable for tracing an imaginary watershed between the St. Louis River and other streams, making liberal allowances against this river. A calculation of the area enclosed in this line showed that it amounted to 3,732 *square miles.* Mr. Guy Wells calculated *the drainage-area of the St. Louis River to be* 3,860 *square miles.* In a country as yet but partially explored and surveyed, an element of uncertainty enters into all estimates; but, as Mr. Wells had access to the surveys which the Government engineers had made of the drainage-basin of the upper Mississippi River, his figures are considered the most reliable possible to obtain without actual surveys, and his estimate will be used in the following calculations.

Mr. E. C. Burns, C. E., in his report, says: "The drainage-area of the St. Louis River, using the latest published sectional map of Minnesota, is estimated at 3,590 square miles. Mr. Birkinbine estimated it at 3,732 square miles, but used, in his estimate of the flow of the stream, 3,860 square miles. The reason for these discrepancies is found in the fact that the drainage-area of the St. Louis River was not surveyed until recently, and even the latest maps show a portion of the territory as unsurveyed—in fact, a "terra incognita."

Mr. R. C. Reid, C. E., estimated the watershed of the St. Louis River at 3,700 square miles.

Mr. James B. Francis, C. E., states that the drainage-area of the St. Louis River is approximately equal to that of the Merrimac River at Lowell, Mass., whose water-power is such an important factor in local development.

In the absence of more definite data, it would appear equitable to take an average of the four estimates, viz.:

Wells's estimate, ...	3,860	square	miles.
Burns's estimate, ...	3,590	"	"
Reid's estimate, ...	3,700	"	"
Birkinbine's estimate, ...	3,732	"	"
Average of the four estimates, .	3,721	"	"

Or practically the figures given in my first report.

RAINFALL.

To determine the precipitation and calculate the flow of the stream, I have studied carefully the reports of the Engineer Corps of the United States Army, relating to the "Preservation of the Falls of St. Anthony" and "Examinations for Reservoirs at the Sources of the Mississippi River," as furnishing the most reliable comparative data of territory near to the St. Louis River. In these reports, the average rainfall at various points in the drainage-area of the Mississippi and adjacent territory is given, and contemporaneous records show that at Duluth the annual rainfall exceeds that of St. Paul by about eleven per cent., and that the precipitation is greater at Duluth than on the territory at the headwaters of the Mississippi River.

For eleven years, the average yearly precipitation at Duluth was 34.44 inches, or 2.87 feet; 73.76 per cent. of the total occurring between May and October, leaving but 26.24 per cent., or 0.753 foot, for the six winter months. The severity of the winter closes up many sources of supply; and therefore, for these two reasons, low water must generally be estimated as occurring in winter, although there are periodical droughts at other seasons.

The gaugings made for the construction of the dams on the headwaters of the Mississippi River show an average yearly rainfall of twentyfive inches, or 2.0833 feet. In calculations for the construction of storage-reservoirs at Leech Lake, Winnebigoshish Lake, and other sources of the Mississippi River, the United States Engineer Corps assumes the mean annual rainfall at this figure (25 inches); and, for the available quantity, that which actually finds its way into the streams, 0.7 foot was estimated, a figure that must certainly lie within the limits of safety.

VOLUME OF WATER IN THE ST. LOUIS RIVER.

The total area drained by the Mississippi River above the Falls of St. Anthony is given at a little over 20,000 square miles, and the average rainfall on this area thirty inches, of which from six to nine inches are available at Minneapolis. The minimum

flow where the river is free from ice is above 0.2 cubic foot per second for each mile of watershed; but, in the extraordinarily severe winter of 1881, when measured under ice 3½ feet thick, the flow was but 0.16 cubic foot per second per square mile.

Mr. Burns obtains comparative data from gaugings of the Crow Wing, a tributary of the Mississippi River, which has a drainage-area of 3,576 square miles. He says: "The topographical characters of the two basins, judging from the maps and such other information as could be had, are very similar, there being about the same amounts of lake and swamp area in each, thus giving equal storage-capacity. In 1881 and 1882, a series of gaugings of the Crow Wing River were made by the United States engineers* which gave a mean monthly flow for the months of January and February of 950 cubic feet per second, which is equal to 0.266 cubic foot per second per square mile of drainage-area.

"On the Upper Mississippi, above the Crow Wing, where gaugings were made covering the same period, the flow per second per square mile was found to be 0.3 cubic foot. The Mississippi heads much nearer the St. Louis, some of its branches interlacing with those of the St. Louis, and it is probably more nearly subject to the same climatic influence as the St. Louis than the Crow Wing; but, owing to its much greater lake-area, diminution of flow due to frost is probably not quite so great.

"Taking a mean of these quantities, we have, as the probable average lowest winter monthly flow of the St. Louis, 0.283 cubic foot per second per square mile, equal to 1,016 cubic feet per second.

"During the winter of 1883 and 1884, gaugings were made on the Upper Mississippi at Pokegema Falls. The mean monthly flow during January and February was found to be 500 cubic feet per second.† The drainage-area of the basin was 3,298 square miles, giving a flow of 0.151 cubic foot per second per square mile."

Mr. Reid says: "With an observed rainfall of 32.58 inches in the basin of the St. Croix River [another tributary of the

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*See Report of Chief of United States Engineers, 1883.

† Report of Chief Engineer, U. S. A., 1884.

Mississippi River], the average flow was 1,200 feet per second, and the minimum monthly flow 0.454 cubic foot per second per square mile."

Reference has been made to the absence of actual gaugings of the St. Louis River, but several rough gaugings have been made; and, in 1871, the United States engineers measured the flow of the St. Louis River at Fond du Lac, to determine the influence of the artificial entrance-channel cut through Minnesota Point, opposite Duluth. These gaugings showed that the mean daily flow was, in

May, 1871,	5,926	cubic feet	per second.
June, 1871,	5,859	"	"
July, 1871,	4,968	"	"
August, 1871,	2,795	"	"

A minimum of 1,350 cubic feet per second having also been determined.

On May 24th, 1870, Mr. J. B. Francis, C. E., states that he "made rough observations on the flow of water through a section of the 'dalles' just above the railroad-bridge at Thomson, from which I find that the quantity then flowing was about 5,600 cubic feet per second. The river was then evidently above its minimum flow, which is all that it would be worth while to prepare for utilizing."

He says: "In the absence of definite data, I assume the minimum flow of the St. Louis River at 2,000 cubic feet per second."

During a personal inspection of the "dalles" of the St. Louis River, in May, 1883, which was at a time when the stream was reported as being unusually low, and when immense quantities of logs were "hung up" for want of sufficient water to "drive" them, estimates of the volume of water flowing in the stream were made by means of floats at several points between Fond du Lac and Thomson, which showed a volume of from 3,500 to 4,200 cubic feet per second.

Although there may be at long intervals a drought or protracted intense cold to reduce the available flow of the stream, the following, taken from my report of 1883, would appear to hold good: "To allow for a possibly smaller precipitation on the drainage-area of the St. Louis River than at Duluth, we will

assume as a safe basis that *the average flow of the stream can be depended upon as equivalent to* 0.6 *cubic foot per second for each square mile of area drained;* but its minimum flow would probably seldom fall below 0.3 cubic foot per second per square mile."

In commenting upon the flow of the river, Mr. Reid says: "The rivers in this district are lowest when the sources are frozen up, and it is probable that in extremely severe winters the minimum may fall to 0.3 foot per second per square mile, or 1,110 feet per second; but such seasons are exceptional, only lasting for a short period. In the nine months from March to November, when the trade is most active and the navigation of the lakes open, the flow is not likely to fall below 2,400 feet per second, and this may be taken as the workable volume of the river. On the upper reaches of the St. Louis River, there are many lakes and swamps which at little cost could be raised and converted into storage-reservoirs, by which the discharge could be uniformly maintained at even more than 2,400 feet per second."

Concerning the flow, Mr. Burns says: "The minimum flow of extreme years may be disregarded, for the character of the headwaters of the St. Louis River is such that storage-reservoirs can be easily and cheaply built, and by this means the flow of the stream may be so regulated that it need never fall below its average winter minimum, and could undoubtedly be kept at or near its summer flow." Therefore, again quoting from my report of 1883, "the available flow of the St. Louis River at Fond du Lac may be taken as 0.3 x 3,860 equals 1,158 cubic feet per second. Each improvement will, by adding storage, augment this possible minimum, and 1,200 *cubic feet per second will be taken as the minimum and* 2,400 *cubic feet per second the ordinary average winter flow. This is equivalent to* 100 *and* 200 *horse-power respectively for each foot of fall utilized.*

Another reason for practically ignoring the exceptionally low flow during weather of unusual severity is that in all machinery some contingencies arise which demand cessation of work, and it is probable that recurrences of such character as would reduce the flow abnormally would be no more numerous than stoppages or reductions of power at establishments run with steam-machinery.

As no definite surveys were made of particular locations on the upper waters of the St. Louis River, the possibility of augmenting the minimum or average flow by impounding-reservoirs has not been critically considered; but it is probable that ample facilities exist for storage, which will materially improve the minimum or average flow when required, and overcome such contingencies as ordinarily severe weather produces.

HORSE-POWER OF THE ST. LOUIS RIVER.

As before stated, the total measured fall between Thomson and Fond du Lac is 443 feet. If all of this could be utilized, it would give, on the basis above established, an aggregate of 44,300 horse-power for the minimum winter flow, and 88,600 horse-power for the average winter flow, while, for a part of the year, fully 130,000 horse-power could be depended upon. Mr. Francis, in his report, states that, "if but 300 feet of the fall between Thomson and Fond du Lac be utilized, the minimum flow of 2,000 cubic feet per second would give an actual power of about 68,000 horse-power, from which could be realized, by the use of ordinary water-wheels, about 40,000 horse-power."

The plans, as perfected, purpose utilizing 364 feet of the fall, which would be *equivalent to* 36,400 *horse-power at the minimum winter flow, and* 72,800 *horse-power for the average winter flow.* These figures, though large, are not appreciable except by some comparisons, and the following are submitted:

1st. The minimum flow of the Mississippi River at Minneapolis is 4,000 cubic feet per second. The direct fall is fortyfive feet; but, within three-quarters of a mile, the total fall is seventy-five feet, and between Minneapolis and St. Paul the declivity of the river is 110 feet. If, therefore, the whole fall between these two cities was utilized, the power to be depended upon from this fall would be less than 37,000 horse-power, while that which could be secured by utilizing the total fall of the St. Louis River between Fond du Lac and Thomson would be 48,000 horse-power at its minimum flow of 1,200 cubic feet per second. At present, but fiftyfour feet of the fall at Minneapolis is utilized. This, at

the minimum flow of the Mississippi River, is equivalent to 18,000 horse-power. By the improvements suggested to utilize 364 feet of the fall of the St. Louis River, the power developed at a minimum flow of 1,200 cubic feet per second will be double what can be depended on from the Falls of St. Anthony under present arrangements.

2d. Exceptionally economical steam-power will consume an average of two pounds of good coal per horse-power per hour, but the average motors in use require fully four pounds per hour. Steam-machinery operating continuously would aggregate a consumption of $8\frac{3}{4}$ tons of fuel per horse-power per annum for the best and 17.5 tons per annum for average apparatus now in use. The power made available by utilizing 364 feet of the fall of the St. Louis River would therefore be equivalent at the minimum winter flow to that obtained by the consumption of 637,000 tons of coal, and at the average winter flow to the power obtained from 1,274,000 tons of coal, burned under fairly economical boilers, supplying steam to motors of ordinary efficiency. To produce an amount of power by steam-boilers equal to that developed by the average winter flow of the St. Louis River would require about 1,600 boilers of the size and form common in the Northwest—say cylinders fortytwo inches in diameter and thirty feet long, with two fourteen-inch flues.

3d. The 72,800 horse-power constantly developed by the average winter flow of the St. Louis River would be sufficient, if applied (through machinery of proper construction and arrangement) to pumping water for cities and towns, to supply an aggregate population of 30,000,000 people with seventyfive gallons each daily, raised to an elevation of 150 feet.

In estimating the horse-power of the river, one cubic foot of water falling twelve feet per second is taken as equivalent to one horse-power; this allows $26\frac{2}{3}$ per cent. to be consumed by motors.

APPLICATION OF THE WATER-POWER OF THE ST. LOUIS RIVER.

Having estimated the aggregate power which can be developed by the St. Louis River between Thomson and Fond du

Lac, the means of its application and the purposes for which it can be used most advantageously should be considered.

The plans proposed by St. Louis River Water-power Company allow twenty per cent. of the fall to remain unapplied, and, if the locations of industries are confined strictly to the immediate banks of the river, it is hardly probable that more than four-fifths of the fall can be economically employed; but it is not necessary that the utilization of the power should in all cases be close to the stream. It is probable that much of the application of the power will be made through turbine-wheels, which can be connected directly to the machinery of mills, factories, etc., or the power can be transmitted by means of wire ropes to works located at a distance, thus making available numerous excellent sites convenient to the stream.*

The rapid development of the application of electrical force also opens a wide field of possibilities for generating electricity with power obtained from water-wheels and conveying it by proper conductors to any desired distance. Whether or not the utilization of a portion of the water-power of the St. Louis River could be advantageously directed to maintaining the electric-light systems of Duluth, Superior City, and of the harbor, is worthy of serious consideration; the cost of generation will be much less than by using steam as a motive-power, but the cost of maintaining suitable conductors, and the item of loss in transmitting the electricity fifteen miles, will be a partial offset to this.†

Another means of utilizing the power of the stream at locations distant from it is by means of compressed air. The air may be delivered under any pressure found most advantageous, developed in cylinders the pistons of which receive motion either from turbine-wheels or from other cylinders which are operated directly by water under pressure. These last-mentioned motors are known

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* At Schaffhausen, on the Rhine, 700 horse-power is conveyed by wire ropes 3,000 feet from turbine-wheels and distributed to works throughout the town. Numerous instances of transmitting large powers by wire rope might be mentioned in connection with American manufactories.

† Late advices report the formation of a company at Valencia, Spain, to supply 3,000 to 4,000 horse-power to manufacturing-industries within a limit of thirtyfive miles. The power is to be furnished by an electric plant operated by water-power.

as "water-pressure engines" and are used to a limited extent in the United States, but are more common in Europe. The largest of these machines in the United States is connected with the high-service system of the Washington, D. C., aqueduct. Where the head is excessive, they would appear to be more economical than the use of turbines, particularly where the high rotative velocity due to the fall must be reduced to suit the demands of the purpose to which the power is applied, thus losing by gearing or belting a considerable proportion of the power.

The use of compressed air has grown rapidly in late years,* and few large mines now are without air-compressors to drive rock-drills; in some instances, pumps and locomotives are operated by compressed air, and several of the most important mines of the Lake Superior region depend upon compressed air as the principal source for all power.

The waterfalls at Quinnisec and Michigamme, Michigan, are utilized by means of turbine-wheels driving—through gearing—air-compressors which supply air by conduits to the mines, which are several miles distant. Mr. Per Larsson, M.E., states that "the mining-machinery at the Chapin mine and also at its neighbor, the Ludington mine, is driven chiefly by compressed air furnished by a plant of air-compressors located at Quinnesec Falls on the Menominee River, about three miles from the mines. The average delivery of air per twentyfour hours during 1886 was 1,827,350 cubic feet of sixty pounds' pressure and 60° F. temperature. The pressure at the mines was from two to three pounds less than at the receiver." From this, the possibility of generating power at the "dalles" of the St. Louis River and conveying it by compressed air to Duluth and vicinity would appear favorable.

In all methods of transmission of power, there is a percentage of loss; and a careful study of each particular location, in connection with the special industry to be operated, must determine the best mode of utilizing the water-power.

It will hardly be practicable to use the entire fall of the river, but it is probable that a thorough development may

*A company is reported as organized in London to distribute power to buildings by means of compressed air.

eventually secure the power represented by 95 per cent. of the total declivity between Fond du Lac and Thomson; for present purposes, however, only so much of the fall as is estimated for in the plans already suggested—viz., 364 feet—will be considered as available.

INDUSTRIES SUGGESTED.

In the immediate future, there would seem particular encouragement for milling and lumber industries on the St. Louis River; but the augmenting population of Minnesota, Wisconsin, and adjacent territory will soon make the water-power valuable for other purposes, particularly in a section which, as far as is known, has no convenient local supply of mineral fuel. (The coal-supply will be referred to further on.) Of the two industries named, milling offers apparently better inducements. There is so much waste which can be used as fuel in saw-mills that the economy of water-power is not so notable as in other industries, and the demand for manufactured lumber is growing from the West; so that much of the lumber carried in logs below Thomson would, after being cut, be transported back again. Therefore, the logs can as well be sent through the "dalles" to the booms.

Lumber. The Duluth Daily News states that "within a decade, the manufacture of lumber in the Duluth district has grown from comparatively nothing to a grand total of nearly 225,000,000 feet of pine lumber, 80,000,000 shingles, and 71,550,000 laths, besides a large quantity of other soft varieties of wood, and quite a respectable total of oak and fancy hard woods. By rail and lake, the manufactured article in this district has been shipped in all directions, and the large increase of manufacture in 1887 over that of the previous year bids fair to be eclipsed in that promised for 1888. Nearly 300,000,000 feet of logs will be cut in this district during the present season (1887-1888); and this, with a surplus of about 30,000,000 which did not reach the booms, will be turned into lumber, laths, and shingles by the mills already enumerated. On streams tributary to the St. Louis River, and which have been thoroughly explored, it is estimated that there is now standing at least 2,000,000,000 feet of the finest pine on American soil."

The interests of the St. Louis River Water-power Company would seem rather to favor logging to its booms below Fond du Lac than to encouraging saw-mills along the river, for the booming would probably bring as much revenue as the leasing of water-power, and the saw-dust from a large lumber-industry would in time cause annoyance at dams, waterways, etc.

FLOUR. The facilities for milling and the production of flour on the St. Louis River appear to be unusual. Already Duluth is one of the largest wheat-shipping points, and much of the flour made in Minneapolis is transported to Duluth for delivery to lake-vessels.

Duluth shipped in 1887 almost 20,000,000 bushels of grain and 1,322,725 barrels of flour, all but about 125,000 barrels of the latter coming from Minneapolis. During the years 1885, 1886, and 1887, nearly four million barrels of Minneapolis flour were shipped via Duluth, at a cost of not less than $1,000,000 for freight and handling, over what would have been necessary on flour produced at the head of Lake Superior. These figures would offer encouragement to believe that the grain brought to the head of navigation could there be made into flour to advantage, and the trade of the magnitude shown by the above figures is sufficient for establishing a ready market.

In the statistics of traffic through the St. Mary ship-canal, we find that for the years 1885 and 1886 the following:

	1885.	1886.
Flour (barrels), ...	1,440,093	1,759,365
Grain (bushels), ...	15,697,194	19,706,858

Nearly all of which was loaded in Superior Bay.

When it is remembered that the great grain-growing territory of Minnesota, Dakota, Montana, and Manitoba exceeds an area of 600,000 square miles, and is populated by fully 3,000,000 inhabitants,* of whom nearly one-half reside in Minnesota, the value to be obtained by such utilization of the water-power of the St. Louis River may be appreciated; for it would appear advantageous to reduce the wheat from this grand grain-growing territory to flour at the head of navigation, and employ the power of the St. Louis River for this purpose.

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* Five-sevenths of the area of the United States, excluding Alaska, lies west of the Mississippi River, and has a population of 10,000,000.

The importance of Superior Bay as a shipping-point is well shown by the coal-receipts, which have been as follows:

1884, ...	375,000 tons.
1885, ...	695,000 "
1886, ...	736,000 "
1887, ...	1,044,000 "

This coal is distributed throughout the Northwest for fuel, sustaining many industries and adding to the comfort of the inhabitants. This trade will continue to grow, and the volume of it should maintain cheap freight-rates on grain coming east for shipment or for conversion into flour.

Although coal is unusually cheap at Duluth, owing to back-freights by lake, the cost of fuel per horse-power will range from $30 to $70 per annum, and water-power can be supplied from the St. Louis River at $10 per horse-power per annum.

Wood-Manufactures. While stress is not laid upon the utilization of the water-power for the lumber-industry, the opportunity for producing wood-manufactures, such as toys, furniture, agricultural and household utensils, would seem to favor a location where the woods of the Northwest could be worked by power generated on the St. Louis River, and freight westward on this bulky material saved.

Paper. Wood-pulp manufacture is also one of the industries which invite favorable consideration; and the utilization of the straw (which is now burned), by converting it into straw-board, and manufactures into which straw-board enters, may be among the possible industries to be operated by water-power.

Textile Fabrics. The manufacture of textile fabrics from the flax which is largely grown in Minnesota and Dakota—only the seed being at present utilized, the fibre being burned—from the wool grown in the Northwest, and possibly from cotton brought up the Mississippi River, will consume considerable power.

The St. Paul and Minneapolis Pioneer Press says: "One of the most important and growing interests of Duluth is her wool-business, for which the position of the place is especially adapted; and, with the growth of sheep-raising in Montana and in the Pacific Coast States, it is destined to be among her leading industries. In 1886, the wool-growers of Montana, Washington Territory,

and Eastern Oregon shipped to the East, through Duluth, 5,305,017 pounds, all on through way-bills to Philadelphia, New York, or Boston. In 1887, the amount was increased to 6,816,400 pounds, but 1,700,000 pounds were handled by a Duluth firm which made an experiment of the business. Ultimately, a good quantity of the wool brought there will also be manufactured in Duluth. A study of freight-rates between the producing districts and Duluth, and between them and the East, will show the advantage of manufacturing there."

STONE. The sandstone now quarried along the St. Louis River, and the granite which is shipped in quantity from its drainage-area, could be dressed by mechanism operated by water-power; already the trade in building-stone is assuming large proportions, and, to those named, may be added the slate which abounds near Thomson.

IRON. The above does not embrace all of the possible industries; but, in view of the active interest now taken in the establishment of iron and steel manufactures at the head of Lake Superior, the employment of part of this great water-power, either directly or by compressed air, to operate such portions of the plant as do not supply sufficient waste heat for the purpose, must not be overlooked. In short, a study of the territory convenient to the "dalles" of the St. Louis River will demonstrate how numerous are the uses to which the power may be applied and how rapidly they may be augmented. The special requirements of each industry will dictate the proper sites for works and methods of improving the power, and, although certain points have been selected for dams and their height suggested, these are merely to submit a tangible method of improvement; they have, however, been carefully considered.

LOCATIONS FOR DAMS.

An examination of the profile made by Mr. Lehman shows that, between the mouth of Medway Creek and the village of Fond du Lac, the river in a length of ten miles has a fall of 443 feet, which may be increased somewhat by a dam at Thomson. Of this total fall, 350 feet is within 3½ miles of Thomson, and in the remaining 6½ miles the natural fall is 93 feet.

The location of the various improvements suggested are:

Dam No. 1. At the State Line or Falls City, $1\frac{1}{8}$ miles above Fond du Lac.

Dam No. 2. At Railroad Bridge No. 1, on Lot 3, Section 1, $1\frac{1}{8}$ miles above Dam No. 1, or $2\frac{2}{8}$ miles above Fond du Lac.

Dam No. 3. At Section Line 11, $2\frac{1}{8}$ miles above Dam No. 2, or 5 miles above Fond du Lac.

Dam No. 4. On Lot 7, Section 10, opposite Railroad Bridge No. 5, $1\frac{1}{2}$ miles above Dam No. 3, or $6\frac{1}{2}$ miles above Fond du Lac.

Dam No. 5. One-half mile above Dam No. 4, or 7 miles above Fond du Lac.

Dam No. 6. One-third mile above Dam No. 5, or $7\frac{1}{3}$ miles above Fond du Lac.

Dam No. 7. One-third mile above Dam No. 6, or $7\frac{2}{3}$ miles above Fond du Lac.

Dam No. 8. One-third mile above Dam No. 7, or 8 miles above Fond du Lac.

Dam No. 9. One-half mile above Dam No. 8, on Lot 3, Section 9, or $8\frac{1}{2}$ miles above Fond du Lac.

Dam No. 10. At Thomson, on Lot 5, Section 6, $1\frac{1}{2}$ miles above Dam No. 9, and 10 miles above Fond du Lac by the river.

The height of these dams, and the head and fall which can be obtained by the dam and races, as well as the horse-power which can be supplied by each under the minimum and average winter flow as above determined, are as follows:

	Height.	Head and Fall.	Horse-Power.*	
			Minimum.	Average.
Dam No. 1	20 feet	30 feet	3,000	6,000
" 2	15 "	20 "	2,000	4,000
" 3	15 "	20 "	2,000	4,000
" 4	10 "	40 "	4,000	8,000
" 5	10 "	30 "	3,000	6,000
" 6	10 "	25 "	2,500	5,000
" 7	10 "	40 "	4,000	8,000
" 8	10 "	30 "	3,000	6,000
" 9	15 "	25 "	2,500	5,000
" 10	9 "	104 "	10,400	20,800
Total . . .	124 feet	364 feet	36,400	72,800

*The columns marked "minimum" and "average" represent the power represented by the minimum and average winter flows as above determined.

No detailed mention need at present be made of any of the above sites except of Dams Nos. 1 and 10.

Dam No. 1 will be located at the foot of the rapids or "dalles," one and a half miles above the head of navigation, where the river has rock bottom and sides. This dam, which will be 800 feet long and twenty feet high, will turn the river into a valley on the south side—supposed to be an old river-bed—which enters the stream again below the head of navigation. This, forming a natural basin for the water, of several hundred acres' area, should make a valuable location, particularly in view of the fact that, at a comparatively small cost for dredging, the river and bay from this point to Duluth and Superior can be made navigable for the largest boats on the lakes to load and unload at the outlet of the old channel or valley.

A berm bank, fitted with head-gates, waste-flume, and timber chute, can be conveniently constructed at the lower end of this valley, and ample room given for the location of factories or mills on navigable water. At present, boats drawing seven feet of water can reach this point, and there is a constant traffic being carried on by scows heavily laden with brown-stone from the quarries one-half mile above, which are convoyed by tugs to Superior Bay. Therefore, without dredging, grain could now be brought from the Duluth elevators to mills, and flour carried back by lighters. This locality is unique, and offers unusual facilities for developing a water-power at a limited expense which will furnish 3,000 horse-power at the minimum and 6,000 horse-power at the average winter flow. It can also be readily reached by either the St. Paul and Duluth Railroad or the Northern Pacific Railroad, and there is no serious obstruction to other roads being connected to it.

Dam No. 10 is located so that, by utilizing a natural channel between slate dykes, a head-race and pool are formed about 4,500 feet long, to secure a head of over 100 feet, when the water is again discharged into the river.

But, if the location of industries favors dividing this fall, it can be utilized by two or three powers, one below the very picturesque cataract at Thomson, where a fall of sixty feet can be secured in a distance of 500 feet, and others farther down the stream.

The topographical map, on which the various dams are located, will show in a general way the possible locations for head and tail races, as well as sites where industries could be located close to the stream.

PROPERTY OF THE ST. LOUIS RIVER WATER-POWER COMPANY.

The map also indicates the property of the St. Louis River Water-power Company, which is convenient to the stream. This company, a corporation organized under the laws of the State of Wisconsin, owns about 4,500 *acres of land lying upon either side of the St. Louis River*, from Fond du Lac, at the head of navigation, to beyond Thomson, a distance of about eleven miles; this, with the exception of some unimportant points shown on the accompanying map, gives the company complete control of the St. Louis River between these places. It also owns land and controls booms along the navigable portion of the river.

There are good brown-stone quarries on these lands near Fond du Lac, so situated that shipments can be made (by water) which afford a very fair return for working.

At Thomson, an apparently good quality of slate crops out for a considerable distance. Some of the slate has been favorably reported upon, and some of it has been used.

The lands are well wooded, a portion of which is marketable timber. Nearly all of the timber needed in the construction of the dams could be obtained upon the adjacent lands owned by the company.

All of the stone for buildings can be taken from this property.

EARNING-CAPACITY.

The various water-power companies throughout the country sell their privileges either by measurement through certain apertures or channels or over weirs, and also by calculated or indicated horse-power. A fair basis would be a rate of $10 per horse-power per annum; this is much below the cost of producing a horse-power by steam at the head of Lake Superior, and would

yield a revenue which would pay the St. Louis River Water-power Company, at the minimum winter flow (the horse-power as above determined being 36,400), a yearly revenue of $364,000; and the average winter flow would produce an income of $728,000 per annum. If there were demands for additional power during the season of navigation, when increased shipments would be expected, or if the erection of storage-reservoirs or the utilization of a greater percentage of the fall augments this power, the income would be commensurately greater. This, as exhibited by the estimates prepared, would, after paying liberally for interest on the cost of the dams, races, and improvements, leave a very satisfactory profit.

Fortunately, the location is such that the improvements need not be made at one time, but can be constructed as needed; therefore the utilization of this power should give a satisfactory return as soon as any of the power is developed.

In addition, the company would obtain revenue from the booms now constructed, and others which may be added, and also from sales or leases of property.

The rapid growth of the cities of Duluth, Minn., and Superior, Wis., which have a joint harbor in Superior and St. Louis Bays, promises soon to show extensions of these two corporations toward the St. Louis River. Already industries and residences are being located on St. Louis Bay, and those best acquainted with Lake Superior and its resources do not hesitate to prophesy a continued settlement as far up as Fond du Lac.

RESOURCES.

In a discussion of the utilization of the St. Louis River water-power, it becomes necessary to examine into the present and prospective commercial status of the section of the country close to the portion of the river where industries could be operated by the power developed. To those who are familiar with the rapid growth of St. Paul, Minneapolis, and Duluth, and the resources of the grain-growing territory tributary to these cities, no argument need be advanced to prove that the prosperity with which the region has been favored will continue; and the record of what

the Falls of St. Anthony on the Mississippi River has done for Minneapolis naturally augurs for similar advantages arising from the utilization of the water-power of the St. Louis River. As has been stated, this river flows into the head of Lake Superior, and is claimed to be its most important tributary. The location, then, at the western extremity of the great chain of inland seas giving a system of navigation for 1,500 miles, appears to be one where railroad and water transportation must naturally meet and the already heavy traffic be continually augmented. The importance of the shipping-interests of the lakes is hardly appreciated even by those familiar with the extent and areas of these great bodies of water.

The report of Mr. C. B. Morton, the United States Commissioner of Navigation, for the fiscal year ending June 30th, 1887, shows that the total documented tonnage of the United States is 4,105,844 tons, of which 783,722 tons are credited to the Northwestern lakes, 2,638,272 tons to the Atlantic Ocean and Gulf of Mexico, and 356,445 tons to the Pacific Coast, and 327,405 to the Western rivers. The foreign-going registered tonnage is 1,015,562 tons. There are now reported as engaged in the commerce of the lakes nearly 1,900 American vessels, representing an investment of $40,000,000 capital. Some of these vessels are of sufficient capacity to carry at a single trip the grain that would load five freight-trains of thirty cars each with over 600 bushels per car.

The traffic of Lake Superior is shown in detail by the records of the Sault Ste. Marie ship-canal, by which vessels pass from Lake Superior into Lakes Michigan, Huron, and Erie. The St. Mary strait is seventyfive miles long. In this distance, there is a fall of twenty feet four inches; eighteen feet two inches of this is at the "Sault," the remainder of the descent—two feet two inches—is distributed over the first thirtyfive miles below the "Sault." The improvement of the St. Mary River began in 1852, in the construction of the first lock at the "Sault" with two chambers, each seventy feet wide and 350 feet long between gates, passing vessels drawing a maximum of eleven and one-half feet of water. This structure, opened for business in 1855, met the immediate wants of the early development around the shores of Lake Superior, especially in iron and copper ore production.

The first year's tonnage through the lock was 100,000 tons; five years later, it was 400,000 tons; ten years later, 700,000 tons; in 1875, 1,260,000; and in 1880, 1,750,000 tons. The growth of the traffic had, however, been so rapid that another lock was constructed, the dimensions of which are: Length, 515 feet; width, eighty feet; and seventeen feet of water over the miter-sill. It was opened for business September 1st, 1881. While this work was in progress, extensive improvements were made in the canal above the lock and at different points in the river below, by which was obtained nearly an equal depth of water with that carried by the lock—sixteen feet. Now this lock is to be supplanted by another which will occupy the site of the original lock of 1855, will be 800 feet long, 100 feet wide, and with twentyone feet of water over the miter-sill. The completion of the works now fairly under way will secure deep water—twenty feet—throughout the entire lake-system.

The Dominion Parliament has appropriated $1,000,000 for a similar lock on the Canadian side of the "Sault."

The registered tonnage passing the canal during the season of 1886 was 4,219,397 tons, the freight-tonnage 4,527,759 tons. The ratio of increase over 1885 was 39 per cent. In 1886, the Suez Canal accommodated 5,767,756 tons during the 365 days, or an average per day of 15,802 tons. During the two hundred and twentythree days of 1886 in which the St. Mary Falls Canal was open to navigation, it accommodated 4,219,397 registered tons, an average of 18,837 tons per day, or nearly in the proportion of 5 to 4, as compared with the Suez Canal.

The memorial of the Waterways Commission prepared for Congress, from which some of the above data were obtained, shows that in 1886, in addition to the heavy iron-ore and copper shipments, there were 1,010,000 tons of coal and 115,208 tons of manufactured iron and steel going from Ohio and Pennsylvania, and 158,677 barrels of salt from New York and Michigan, to the Northwest; and there were 1,759,365 barrels of flour, 19,706,858 bushels of wheat and other grains, and 138,688 million feet of lumber, with wool from Montana, and 2,000 tons of silver-ore out of the far Northwest, destined for our Eastern markets and Europe. The tonnage of 1887, it is now ascertained, will show an enormous increase over that of 1886.

In addition to the traffic which passes through the Sault Ste. Marie Canal, Lake Superior has considerable coastwise or local trade, as may be presumed from its dimensions: Length, 375 miles; width, 150 miles; area, 32,000 square miles.

Of the freights above mentioned as passing through the canal, a large proportion was destined for or came from the head of Lake Superior, and the following data show the business transacted on Superior Bay, into which the waters of the St. Louis River flow:

Arrivals and clearances in 1887, . . .	2,474
Vessels, tonnage, ...	2,030,767
Grain-shipments, ...	20,007,965 bushels.
Lumber-shipments, ...	5,000,000 feet, B. M.
Coal-receipts, ...	626,000 tons.

One-third of the vessels and 40 per cent. of the freight through the Sault Ste. Marie Canal were shipped from or received at Superior Bay.

The location of Duluth and Superior at the west end of the great lake extending farthest inland toward the center of the continent and nearest to the grain-fields, cattle-ranches, and rich mineral deposits, is of course the key to their commercial development.

Mr. W. F. Phelps, Secretary Duluth Chamber of Commerce, states that, if a line be drawn from the southeast corner of Minnesota through the southwest corner of New Mexico, every point on that line is equally distant from Chicago and Duluth, and hence all the territory lying north and west of that line is nearer to Duluth than it is to Chicago; the distance to Buffalo by water is practically the same from both cities.

This harbor is magnificent in the extent of its dock and vessel room and in the protection it affords from storms. It is a natural harbor, made up of the Bay of Superior or Duluth, of the Bay of St. Louis, and Allouez Bay, the latter on the Wisconsin side just east of old Superior. Minnesota Point, extending in a graceful sweep from the center of Duluth south for seven miles on one side, and Wisconsin Point, running out for a long distance on the other, make a natural breakwater.

Between Minnesota and Wisconsin Points is the natural entry known as Superior Entry, but which has been protected

RAILWAYS.

The Duluth railway-system now embraces five completed lines, more building, and others projected. Her present railroads are: St. Paul & Duluth; the Northern Pacific; St. Paul, Minneapolis & Manitoba; Chicago, St. Paul, Minneapolis & Omaha; and Duluth & Iron Range. The Wisconsin Central and the Milwaukee Lake-Shore & Western run cars into Duluth over the Northern Pacific tracks from Ashland.

The mileage controlled by the various roads is as follows:

St. Paul & Duluth,	225
Northern Pacific (part of one branch estimated),	3,182
Manitoba system (new lines estimated),	3,000
Omaha & Northwestern system tributary to Duluth,	4,606
Duluth & Iron Range,	95
	11,108
Wisconsin Central tributary to Duluth,	507
Milwaukee Lake-Shore & Western tributary to Duluth,	470

Four out of five of all the railroads incorporated in the Northwest in the last two years either name Duluth in the title or have this place as an objective point. In the way of eastern outlets, the Duluth South-Shore & Atlantic, which already has its eastern end in operation and has only 120 miles left to build, should reach Duluth about July 1st next. It will give a through line via the south shore of Lake Superior and the "Sault," and connects with the Grand Trunk and the Canadian Pacific. Another important eastern connection is to be made by the Canadian Pacific. The Port-Arthur Duluth & Western, now under contract from Port Arthur west, and building for a considerable distance, is to connect with the Duluth & Iron Range, a gap of about 100 miles, through a rich mineral region, being all that is required. When that is built, there will be an outlet via the north shore of the lake to Montreal, and through connecting links to the East.

The Duluth Huron & Denver Railroad, now being constructed, is to run from Duluth to Huron, and thence to a connection with the Union Pacific in Nebraska. The Duluth Red-Wing & Southern is a southwestern line projected by Southern Minnesota cities to give them a Duluth outlet. Other roads and extensions are promised, all increasing the commercial importance of the head of Lake Superior.

Respectfully submitted,

JOHN BIRKINBINE.

THE ST. LOUIS RIVER WATER-POWER COMPANY.

The St. Louis River Water-power Company was organized for the purpose of utilizing the water-power of the "dalles" of the St. Louis River. Its charter provides for the organization of "a stock corporation under and pursuant to the provisions of Chapters 85 and 86 of Title 19 of the Revised Statutes of the State of Wisconsin for the year 1878, entitled 'Corporations, and of the acts amendatory thereof.'"

The business and purposes of this corporation shall be to conduct a general lumbering and logging business, to engage in the manufacture and sale of all articles or materials that may be produced from wood, stone, iron, or any other material, to purchase or build vessels, to erect saw-mills, flouring and grist mills, pulp and paper mills, quartz-mills and smelting-works, planing and sash mills, agricultural-implement works, etc. Also to engage in mining in any State, to erect booms, dams, and slides on the St. Louis River and Bay, to raft and drive logs, to charge and collect boomage, tonnage, and tolls. Also to create, develop, and deal in water-power, and for such purposes to erect dams, flumes, canals, and locks, head and tail races, reservoirs, waterways, bulkheads, and all structures for the improvement of the navigation of the said rivers or bays. Also to erect, operate, lease, or sell elevators, to construct railways and tramways, street-railways, to erect power-machinery, to deal in water, electric, or steam motive-powers, and to undertake gas-lighting or electric lighting. Also to issue and deliver the stock of the corporation for the purchase or leasing of water-power or any other power, or for the purchase of any franchise which the corporation may desire to obtain or acquire, and to sell for cash, or exchange for other property, any such property, rights, or franchises. Also to purchase, hold, or sell patents and patent-rights, and to encourage and aid inventors by testing the value of their discoveries, etc.

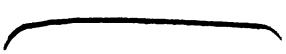
Also to make contracts or agreements with railroad-companies in regard to roads, whether constructed or contemplated, to lay side-tracks and switches connecting such roads with any works or properties of this company. Also to loan or borrow money on securities or otherwise, to mortgage and deal in real or

personal property, to engage in the erection of buildings for use, rent, or sale, to contract for and furnish supplies of any kind of building-material, and to enforce contracts by lien or otherwise upon such buildings. Also to charge boomage or tolls for handling or driving logs or lumber, and to enforce any rights occurring for such charges. Also to purchase, hold, or transfer stock of any other corporation, or to consolidate with any other corporation or corporations, foreign or domestic.

The above is a condensation of the very ample and specific powers of the company, as defined with great fullness of detail in the text of its charter.

OFFICE OF SECRETARY & TREASURER,
Room 21, 119 S. Fourth St.,
Philadelphia, Penna.

DULUTH.

1880.		1887.
3,470	Population,	35,000
$10,186,033	Bank-clearances,	$126,051,360
1,347,675	Bushels of wheat shipped,	19,821,463
551,800	Barrels of flour shipped,	1,800,000
560,000	Elevator-capacity, bushels,	19,350,000
101,000	Receipts of freight by rail, tons,	1,001,654
529	Arrivals and clearances,	2,800
60,000	Tons of coal received,	1,000,000
$669,012	Taxable valuation,	$13,631,230
755	Miles of railroad,	15,103
$50,000	Bank-capital,	$1,811,500

—From the Duluth Daily News.